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ABSTRACT

Much research has been conducted regarding the effectiveness and efficiency of cooperative learning on groups of students. Many student may think they like cooperative learning. Such students, however, may really prefer traditional learning in that same subject if they were taught by the same instructor. Students that have not been taught by the same instructor in that same subject can't accurately determine which method best suits their needs. Therefore, the focus of this study was to give one group of 19 ninth-grade biology students in the Alexandria City, Virginia school district one semester using and promoting only cooperative exercises followed by one semester using and promoting only traditional exercises. The same instructor was used throughout this study. The cooperative learning model consisted of a 3-day cycle of a group quiz, group competition, followed by an individual test. Labs and other activities were also implemented in a cooperative setting. The traditional routine used was teacher lecture, class worksheets, followed by a test. Labs and video presentations were given following the test. An introduction, the methodology, the statistical analysis, and a summary are included. The name of the textbook used in the study, examples of short term and long term achievement tests, and the short term and long term achievement data are appended. (KR)

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A COMPARISON OF COOPERATIVE LEARNING STRATEGIES TO TRADITIONAL LEARNING STRATEGIES USED ON THE SAME GROUP OF MULTICULTURAL NINTH GRADE BIOLOGY STUDENTS DURING THE SAME SCHOOL YEAR

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A Research Paper Regarding a Grant from the Alexandria City School Board Aimed at Improving Existing Programs in This School Division

January 1991

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Abstract

Much research has been conducted regarding the effectiveness and efficiency of cooperative learning on groups of students. Many students may think they like cooperative learning. Such students, however, may really prefer traditional learning in that same subject if they were taught by the same instructor. Students that have not been taught by the same instructor in that same subject can't accurately determine which method best suits their needs. Therefore, the focus of this study was to give one group of nineteen ninth grade biology students one semester using and promoting only cooperative exercises followed by one semester using and promoting only traditional exercises. The same instructor was used throughout this study.

The study was conducted during the 1989-1990 School Year in the Alexandria City, Virginia School District. This School District had approximately nine thousand students. About nine hundred of the nine thousand students attended the junior high school where this study was conducted.

Cooperative learning strategies produced a significant increase in achievement when compared to traditional learning strategies ($p = .0000$). The group also showed a significant increase in achievement across the pretest-posttest continuum ($p = .0001$).

Finally, fifteen of the nineteen subjects in this study preferred the cooperative learning strategies.

This research was a follow-up study to an earlier research paper regarding a grant from the Alexandria City School Board to improve existing programs in that School System. The earlier research may be found in ERIC Document # ED 309 096.

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CHAPTER I

INTRODUCTION

In a two year study by this researcher, it was shown that Black students, other Minorities and White students can all produce significant increases in achievement in biology by using correctly implemented cooperative learning strategies.

This study is a follow up study to the detailed study mentioned above. The details of the above study can be found in ERIC Document # ED 309 096.

The aim of this study was to compare the results of both cooperative and traditional teaching strategies when applied to the same group of students during the same school year in the same course, with the same instructor.

This study was designed to investigate a limitation of the two year study mentioned above.

The cooperative learning model used in this study was the same model used in the two year study mentioned above. It consisted of a three day cycle of a group quiz, group competition, followed by an individual test. Labs and other activities were also implemented in a cooperative setting.

The traditional routine used was teacher lecture, class worksheets, followed by the test. Labs and video presentations were given following the test. No cooperative learning strategies were used for any of the activities involving the traditional routine.

CHAPTER II

METHODOLOGY

Specific Aims of the Study

1. Which of the two different strategies used by the instructor was preferred by the group of students in this study?
2. Which method of instruction produced the highest achievement by the group of students in this study?

Description of Subjects

The group used in this study was from one specific junior high school. Membership at this school was approximately nine hundred students. There were eleven males and eight females in the group. Of the eleven males, there was one black, two orientals, and eight whites. Of the eight females, there was three blacks, one oriental, and four whites. The school was multicultural. More details may be found in ERIC Document # ED 309 096 since the educational atmosphere in that study was similar.

Instruments

Biology subjects were pretested and posttested. This test was the 1989 Biology National Science Olympiad Achievement Test (Appendix B). There were forty multiple choice questions covering basic concepts, processes, and facts that may be covered over a one year course in biology. The pretest was given on September 8, 1989. The posttest was given on June 8, 1990, immediately following the completion of all fifty three chapters in the textbook.

A T-Test for Correlated (non-independent) Samples was used to determine if there was a significant difference between pretest and posttest scores for the group (Appendix C).

A T-Test for Correlated (non-independent) Samples was used to compare the averages on eight tests for students when using cooperative learning with the averages on eight tests for the same students using traditional learning (Appendix C).

A simple questionnaire was given to students on the day of the achievement test on June 8, 1990 to check for student preference regarding traditional or cooperative learning.

Design

A summary of the design may be seen on the following table.

SCHOOL YEAR	GROUP	PRETEST DATE	TREATMENTS	SHORT TERM ACHIEVEMENT	POSTTEST DATE	STATISTIC TO COMPARE
89-90	BIOLOGY	SEPT. 8, 1989	COOPERATIVE Learning Strategies	8 TESTS Covering 320 test items Sept. 29 - Jan. 19	JUNE 8, 1990	T-TEST for Correlated samples
89-90	BIOLOGY	SEPT. 8 1989	TRADITIONAL Learning Strategies	8 TESTS Covering 320 test items Feb. 20 - May 7	JUNE 8, 1990	T-TEST for Correlated samples

This group was taught during the 1989-1990 School Year.

The group of nineteen biology students gained thorough familiarity with the cooperative learning strategies from the first week in September. The short term achievement tests were started on Sept.29, 1989. The last test for achievement regarding cooperative learning was given on January 19, 1990.

At the beginning of the second semester the same group of nineteen biology students gained thorough familiarity with the traditional learning strategies. After several weeks the short term achievement tests were started on February 20, 1990. The last test of achievement regarding traditional learning was given on May 7, 1990.

Test results were statistically compared. The T-Test for Correlated Samples was the statistical method used. It determined if there was a significant difference between the achievement attributed to cooperative learning and the achievement attributed to traditional learning on short term items. The .05 probability level was used.

The 1989 Biology National Science Olympiad Achievement Test was used as the pretest at the beginning of the school year and as the posttest at the end of the school year on June 8, 1990. The .05 probability level was used.

Students were asked to respond to one item regarding their preference for either cooperative learning, or traditional learning. This item was collected on the date of the posttest achievement test on June 8, 1990 immediately following the test.

Procedure

The same text was used by the one group throughout the school year (Appendix A).

Cooperative learning exercises centered around the subject matter in the textbook were given to the group. Short term achievement tests were given. This strategy was used by the instructor the first semester.

Traditional learning exercises consisting of lecture, worksheet,

and test, centered around textbook subject matter, were given to the group the second semester. Short term achievement tests were given. No cooperative learning strategies were used.

At the end of the study, achievement on traditional and cooperative strategies was compared using the short term achievement tests.

A pretest and posttest was given to the group to check for the overall long term achievement accomplished during the school year.

A one question response was solicited at the end of the year to determine which of the two strategies, cooperative or traditional, were preferred by students in the group.

Limitations

1. Students may not have remembered as much about cooperative learning as traditional learning since the questionnaire was given to them following the traditional learning experience.
2. Students may not have voted for cooperative but against traditional learning.

This chapter on Methodology explained the basic structure of the design. It described the aims of the study, description of subjects, instruments, design, procedure, and limitations.

CHAPTER III

STATISTICAL ANALYSIS

For the one group of nineteen ninth grade biology students in the study, two different T-Tests for Correlated Samples were used to measure achievement.

The T-Test determined if there was a significant difference in achievement at the .05 probability level on short term chapter tests using cooperative learning techniques versus tradition learning techniques.

Another T-Test determined if there was a significant increase in achievement test scores across the pretest-posttest continuum.

The App-Stat Statistical Package developed by Statsoft was used to perform the above mentioned T-Tests for Correlated Samples.

The Achievement Tests

Short term achievement was measured using average student scores for eight tests using cooperative learning. Achievement using traditional learning was measured the same way (Appendix B).

The 1989 Biology National Science Olympiad Achievement Test was used to check for long term achievement (Appendix B).

Short Term Achievement Findings from the T-Test

The data file with codes used for short term analysis can be found in Appendix C. This data was gathered from the study. A summary of the T-Test for Correlated (non-independent) Samples can be found in Appendix C.

The T-Test showed a significant improvement in achievement when using cooperative learning strategies as compared to traditional strategies ($p = .0000$).

Long Term Achievement Findings from the T-Test

The data file with codes used for long term analysis can be found in Appendix C. This data was gathered from the study. A summary of the T-Test for Correlated (non-independent) Samples can be found in Appendix C.

The T-Test showed a significant improvement in achievement across the pretest-posttest continuum ($p = .0001$). This was an indication of achievement using both methods during the same year.

Student Preference

Of the nineteen students in the group being studied, fifteen preferred cooperative learning and four preferred traditional learning.

Summary of T-Test Findings

The total biology program for the year, consisting of one semester of cooperative strategies and one semester of traditional strategies produced a significant increase in achievement at the .001 probability level. This achievement shows that both cooperative methods and traditional methods may be used successfully during the same year.

When measuring achievement produced by cooperative learning compared to traditional learning, using short term items as the measure of achievement, it was shown that the cooperative method produced significant increases in achievement ($p = .0000$).

Finally, of the nineteen students in the one group, fifteen preferred cooperative learning.

Thus, cooperative learning was more efficient and effective for the multicultural group of students involved in this study.

CHAPTER IV

SUMMARY

This study was designed to investigate the efficiency and effectiveness of cooperative learning strategies compared to traditional learning strategies used by the same group, with the same instructor and during the same school year.

The subject matter was biology and the subjects studied were nineteen members of a ninth grade multicultural class.

The study was conducted during a one school year period. The group was studied from September 8, 1989 to June 8, 1990. A junior high school in the Alexandria City, Virginia School District was the site of the study. This school had approximately nine hundred students. The school system was multicultural. Two junior high schools housed seventh, eighth, and ninth graders. The one high school educated tenth, eleventh, and twelfth grade students.

The instructor was a white male with over twenty seven years of experience teaching biology and other science courses in the state of Virginia.

Cooperative learning exercises were given to the group during the first semester of the two semester course. Traditional learning exercises were given during the second semester. Short term chapter tests were given during both semesters. These short term items were compared using a T-Test for Correlated Samples. This comparison showed which method of teaching was more efficient.

The researcher administered a pretest at the beginning of the school year and a posttest at the end of the school year to check for long term achievement involving the total school year of biology. The T-Test for Correlated samples was used to measure this long term achievement. It determined the efficiency of the total biology program for the year.

Students picked either cooperative or traditional learning as their preference after using both strategies. This question was given to the subjects at the end of the school year.

The statistical analyses of the gathered data on short term items and long term items showed:

1. There was a significant increase in achievement using cooperative strategies when compared to traditional strategies ($p = .0000$)
2. There was a significant increase in achievement across the pretest-posttest continuum ($p = .0001$)

Finally, fifteen of the nineteen subjects in the study preferred cooperative learning to traditional learning.

It is possible to conceive of the results of this study as applicable to the population of secondary school students taking biology in the ninth grade in similar school districts.

APPENDIX A

TEXTBOOK USED IN THE STUDY

THE GROUP PARTICIPATING IN THIS STUDY USED THE FOLLOWING TEXTBOOK.

Towle, Albert. Modern Biology . New York, New York: Holt, Rinehart and Winston, 1989.

APPENDIX B

EXAMPLES OF SHORT TERM AND LONG TERM ACHIEVEMENT TESTS

SHORT TERM ACHIEVEMENT TEST (GI)

42 Skeletal, Muscular, and Integumentary Systems

Use the diagram to answer the questions that follow. Write the letter of the one best choice in the space provided. (GI) #'s 1-2

1. Which type of blood cell is labeled Y?

   a. lymphocyte
   b. erythrocyte
   c. leukocyte
   d. platelet

2. Which type of blood cell is labeled X?

   a. erythrocyte
   b. platelet
   c. leukocyte
   d. thrombocyte

Choose the one best response. Write the letter of that choice in the space provided. #'s 3-8

3. Muscles that are both involuntary and striated are found in the walls of the:

   a. stomach
   b. heart
   c. intestines
   d. blood vessels

4. Which of the following occurs when a skeletal muscle contracts?

   a. Z bands move farther apart.
   b. Myofibrils relax.
   c. Calcium is released into muscle cytoplasm.
   d. Sarcomeres expand.

5. A primary function of lymph in the dermis is to help the skin:

   a. fight against infection
   b. store food
   c. retain body water
   d. regulate body temperature

6. Which type of joint allows the shoulder to make circular motions?

   a. pivot joint
   b. angular joint
   c. gliding joint
   d. ball-and-socket joint

43 Circulatory and Respiratory System

7. Osteocytes are interspersed throughout the mineral rings c the:

   a. Haversian canal
   b. spongy bone
   c. periosteum
   d. compact bone

8. Which of the following statements accurately describes th stage of ossification that begins in the second month of fetal development?

   a. Osteocytes develop in cartilage.
   b. Epiphyseal plates replace bones.
   c. Compact bone is replaced by spongy bone.
   d. Long plates of the skull are converted to cartilag

Read each statement. If the statement is true, write T in the space provided. If the statement is false, write F in the space provided. #'s 9-18

9. Vocal cords are located in the larynx.

10. The diaphragm contracts during expiration.

11. Gases diffuse from areas of low concentration to areas high concentration.

12. The sinoatrial node is located in the right atrium.

13. Dissolved nutrients are transported by blood plasma.

14. Leukocytes are more numerous than erythrocytes.

15. Platelets play a role in blood clotting.

16. Blood pressure is higher in veins than in arteries.

17. Blood returning to the heart from the lungs enters the lef atrium.

18. The pulmonary veins carry deoxygenated blood.

Choose the one best response. Write the letter of that choice in the space provided. #'s 19-30

19. The atrioventricular node is located in the:

   a. pericardium
   b. right atrium
   c. septum
   d. left ventricle

20. Which type of blood vessel has the thickest walls?

   a. vein
   b. artery
   c. capillary
   d. venule

(GI)

21. Nerve cells that trigger an increase in breathing rate are stimulated by a:

a. high blood CO_2 level
b. high basal metabolic rate
c. low blood CO_2 level
d. low basal metabolic rate

22. Which of the following occurs during inspiration?

a. diaphragm contracts
b. thoracic cavity shrinks
c. abdominal muscles contract
d. thoracic cavity pressure increases

23. Erythrocytes are unusual cells in that they lack:

a. a cell membrane
b. cytoplasm
c. cell proteins
d. a nucleus

24. The two branches of the trachea are called the:

a. arterioles
b. bronchioles
c. alveoli
d. bronchi

25. The heart is divided into left and right sides by the:

a. pericardium
b. septum
c. atrium
d. pleura

26. Blood returning from the body to the heart enters the:

a. right atrium
b. left ventricle
c. left atrium
d. right ventricle

27. What type of tissue lines the thoracic cavity?

a. connective tissue
b. epithelial tissue
c. nervous tissue
d. muscle tissue

28. Which organ system functions to retain body fluids and eliminate waste products?

a. integumentary system
b. circulatory system
c. skeletal system
d. endocrine system

29. The reproductive organs are located within the:

a. dorsal cavity
b. spinal cavity
c. thoracic cavity
d. abdominal cavity

30. Nervous tissue is composed of cells that:

a. support the body
b. move bones
c. transmit messages
d. cover a body part

Read each statement. If the statement is true, write **T** in the space provided. If the statement is false, write **F** in the space provided.

#'s 31-40

31. Actin filaments are directly attached to the Z bands of the sarcomere.

32. The muscle group known as abductors acts by moving limbs away from the body.

33. The outermost skin layer that contains keratin is called the epidermis.

34. The tough outer membrane of the long bone is called the periosteum.

35. The axial skeleton is composed of leg and arm bones.

36. The bones of the vertebral column are held in place by semimovable joints.

37. Smooth muscle is attached to skeletal bones by connective tissue.

38. The ventral cavity surrounds the vertebral column and protects the spinal cord.

39. The dorsal cavity is divided into two regions by the diaphragm.

40. Blood and lymph are classified as connective tissue.

(GI)

LONG TERM ACHIEVEMENT TEST

NATIONAL SCIENCE OLYMPIAD
BIOLOGY CONTEST

30

Biology - 1989
Directions: On the answer sheet, write the letter of the choice that best answers the question or completes the statement.

1. Which type of reproduction is most likely to produce an offspring that most closely resembles the parent?
   a. asexual
   b. meiotic cell division
   c. sexual

2. Which term most precisely describes a human being?
   a. mammal
   b. vertebrate
   c. chordata
   d. Homo sapiens

3. Which instrument could be used to study the nucleus of a cell in greatest detail?
   a. dissecting microscope
   b. 1200 power light microscope
   c. electron microscope
   d. phase-contrast microscope

4. Which of the following organisms produces part of the oxygen found in our atmosphere?
   a. respiration of animals
   b. aerobic bacteria
   c. green plants
   d. yeast

5. An organism is called an autotroph if it
   a. gives off carbon dioxide as a waste product.
   b. is able to synthesize nutrients from inorganic raw materials.
   c. cannot make its own nutrients.
   d. uses a producer as a source of food.

6. Which of the following cell parts is non-living?
   a. nucleus
   b. cell wall
   c. mitochondria
   d. cell membrane

7. Which of the following represents the genotype of a normal female?
   a. XX
   b. XY
   c. XXX
   d. XYY

8. Darwin's Theory of Evolution is based on
   a. use and disuse.
   b. transmission of acquired characteristics to offspring.
   c. natural selection.
   d. mutation of DNA.

9. Green plants need the following basic ingredients: carbon dioxide, water, certain minerals and a source of nitrogen. Which of the following substances produced by the green plant contains the nitrogen?
   a. lipids
   b. carbohydrates
   c. alcohol
   d. proteins

10. The body cells in many organisms, such as man, do not have direct access to the food and oxygen they need to live. In these cases, food and oxygen are supplied to these cells by the
   a. digestive system.
   b. respiratory system.
   c. excretory system.
   d. circulatory system.

11. If all the stomates on a green plant were sealed, the plant could not get
    a. rid of nitrogenous wastes.
    b. the carbon dioxide from the air it needs.
    c. the water it needs.
    d. rid of the excess starch it was storing.

12. Which of the following organisms has a body shaped like a tube that is closed at one end?
    a. sponge
    b. hydra
    c. amoeba
    d. paramecium

13. Which of the following is a characteristic that all living things have in common?
    a. They can make their own food from simple inorganic molecules.
    b. They have a complicated nervous system.
    c. They only arise from other living things.
    d. They have a digestive system.

14. A green plant is placed on a windowsill facing south. Soon all of the leaves bend toward the light coming in the window. This happens because there is
    a. an unequal distribution of auxins in the stems of the plant.
    b. an equal distribution of auxins in the stems of the plant.
    c. an unequal distribution of enzymes in the stems of the plant.
    d. an unequal distribution of ACTH in the stems of the plant.

15. The kidneys are part of the excretory system. They eliminate waste products that are harmful to the organism. The kidneys, therefore, play an important role in
    a. maintaining homeostasis.
    b. regulating the metabolism rate of the organism.
    c. digestion.
    d. respiration.

16. The pH range of two ponds was measured for one year. The results were:

    Pond 1 - pH range 6.2 to 6.8
    Pond 2 - pH range 7.6 to 9.2

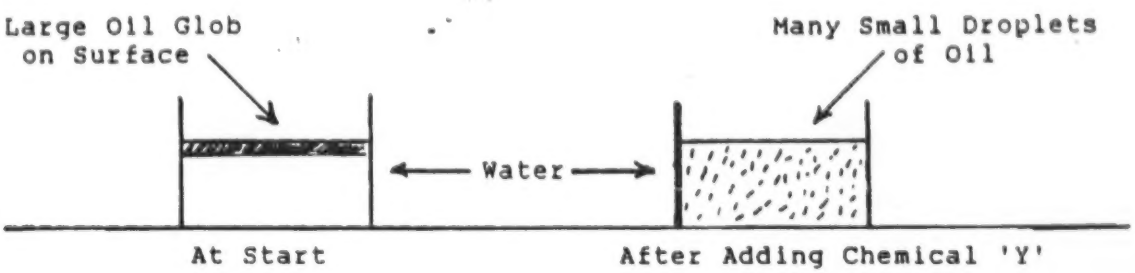
    A particular organism 'x', can only live in water where the number of H^+ ions is greater than the number of OH^- ions. In which pond would organism 'x' be found?
    a. Pond 1
    b. Pond 2
    c. both Ponds 1 and 2
    d. neither pond

17. Some children are born with blonde hair even though both parents have brown hair. This is due to the fact that
    a. a mutation must have occurred.
    b. both parents must have been heterozygous for brown hair.
    c. both parents must have been homozygous dominant for blonde hair.
    d. both parents must have been homozygous recessive for blonde hair.

18. As evolution occurred in man, his reasoning and thinking ability increased. What part of his brain increased in size to make this possible?
    a. cerebellum
    b. medulla
    c. cerebrum
    d. brain stem

USE THE FOLLOWING INFORMATION AND YOUR KNOWLEDGE OF BIOLOGY TO ANSWER QUESTION 19:

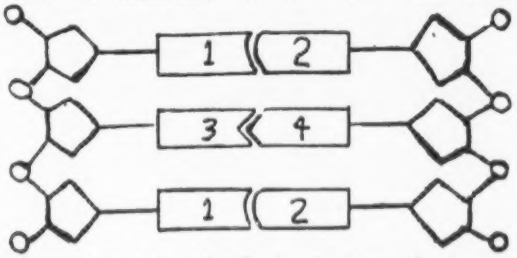
A student set up the following investigation -



19. Chemical 'Y' was most likely
    a. an enzyme.
    b. hydrochloric acid.
    c. a salt such as NaCl.
    d. bile salts.

20. Chlorophyll molecules in algae are similar in physical structure and chemical behavior to those found in a flowering plant. From this you can infer that
    a. all of the proteins in the algae and flowering plant must be identical.
    b. all of the enzymes in the algae and flowering plant must be the same.
    c. algae and flowering plants must have evolved at the same time.
    d. algae and flowering plants may have had a common ancestor.

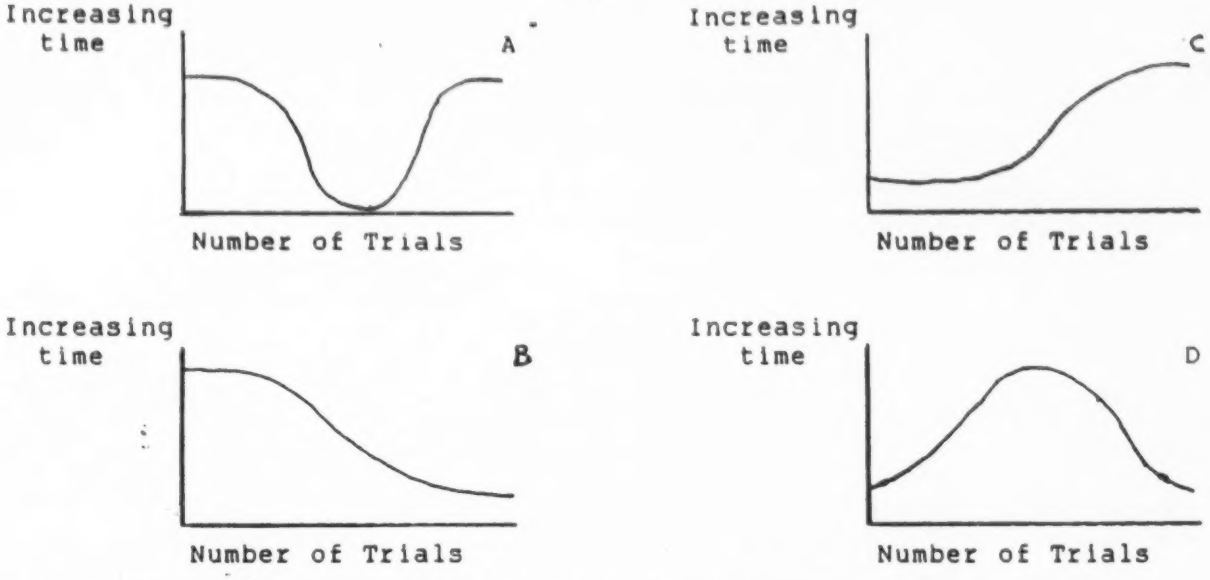
USE THE FOLLOWING DIAGRAM TO ANSWER QUESTIONS 21 AND 22:



21. The parts of the molecule labeled 1,2,3 and 4 are the
    a. deoxyribose sugars.
    b. phosphate groups.
    c. base pairs.
    d. ribose sugars.

22. If number 1 is adenine, then number 2 must be
    a. thymine.
    b. guanine.
    c. cytosine.
    d. uracil.

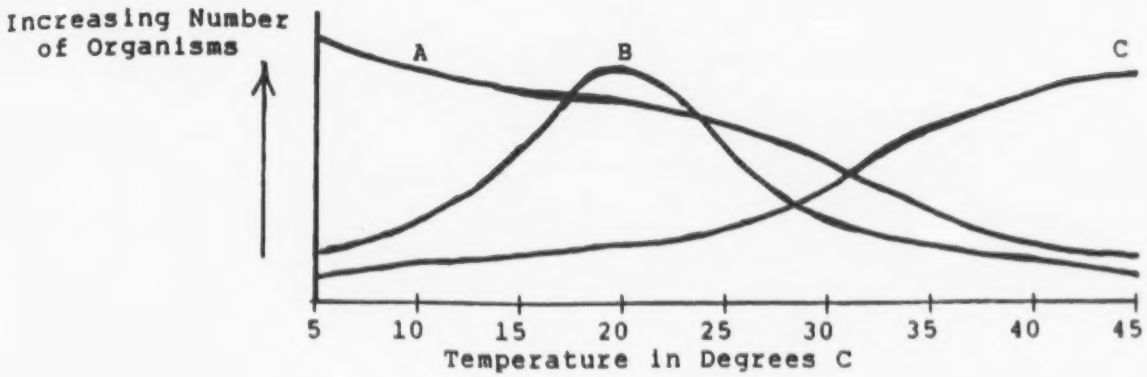
USE THE FOLLOWING GRAPHS TO ANSWER QUESTION 23:



23. A scientist determined the relationship between the number of times a mouse ran through a maze and the amount of time taken for each trial. Which graph best shows the results he obtained?
    a. Graph A
    b. Graph B
    c. Graph C
    d. Graph D

24. A student performed the following investigation. He half-filled a dialysis membrane with concentrated salt water and put it in a beaker of distilled water. Two days later, he observed the membrane and noted that the amount of liquid in the membrane had increased dramatically. This was due to
    a. active transport.
    b. hydrolysis.
    c. osmosis.
    d. pinocytosis.

USE THE FOLLOWING GRAPH TO ANSWER QUESTIONS 25 TO 27:



25. At what temperature would you find the greatest number of organism A?
    a. 5 degrees C
    b. 35 degrees C
    c. 40 degrees C
    d. 15 degrees C

26. Assume that organism C is harmful to the pond's ecosystem. What temperature would keep the population of organism C as low as possible?
    a. between 30 degrees C and 40 degrees C
    b. exactly 30 degrees C
    c. exactly 15 degrees C
    d. between 5 degrees C and 10 degrees C

27. Which organism would be present in the largest numbers if the temperature of the lake was kept at 20 degrees C?
    a. A
    b. B
    c. C
    d. all three - A,B and C

USE THE FOLLOWING INFORMATION TO ANSWER QUESTIONS 28 TO 30:

$$\text{Glucose} + 2\ \text{ATP} \xrightarrow{\text{enzymes}} 2\ \text{Pyruvic acid} + 4\ \text{ATP}$$

$$2\ \text{Pyruvic acid} + \text{oxygen} \xrightarrow{\text{enzymes}} \text{Carbon dioxide} + \text{water} + 34\ \text{ATP}$$

28. The above equation represents a process that is vital to living cells because it illustrates how
    a. a cell converts light energy to chemical energy.
    b. ATP is converted to carbon dioxide and water, releasing energy in the process.
    c. the energy in a carbohydrate molecule is converted to a form that can be used by the cell.
    d. a green plant creates chemical energy.

29. This process is called
    a. fermentation.
    b. glycolysis.
    c. photosynthesis.
    d. respiration.

30. What is the net number of ATP molecules produced by this process?
    a. 34
    b. 4
    c. 36
    d. 42

31. Which of the four physical factors listed below is most responsible for making water go from the roots to the leaves of a maple tree?
    a. hydrolysis
    b. transpiration and capillary action
    c. photosynthesis
    d. osmotic pressure in the roots

32. The end product of carbohydrate digestion is
    a. amino acids.
    b. starch.
    c. glycerol.
    d. monosaccharides.

USE THE FOLLOWING INFORMATION TO ANSWER QUESTIONS 33 AND 34:

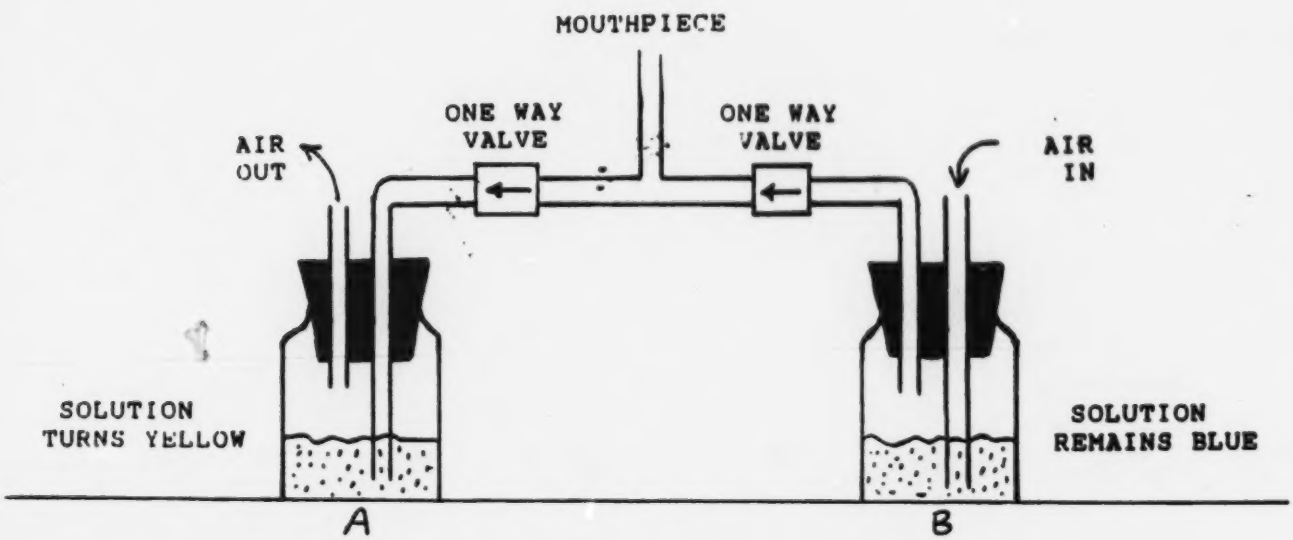
In the early 1600's, Jan Baptist Van Helmont performed a very important experiment. He planted a willow sapling with a mass of 2.27 kilograms in 90.9 kilograms of soil. He covered the soil so nothing could fall into it and watered it whenever necessary. Five years later he found that the tree had gained 74.58 kilograms of mass and the soil had lost .05 kilograms of mass.

33. Which of the following conclusions can be made from the above information? The increase in mass of the willow tree must be due to
a. only something in the soil.
b. both the water added and the air surrounding the tree.
c. only the air surrounding the tree.

34. What important factor did he fail to measure in his experiment?
a. the mass of the water added to the soil
b. the change in mass of the soil
c. the increase in thickness of the tree
d. the mass of the willow at the beginning of the experiment

USE THE FOLLOWING INFORMATION AND YOUR KNOWLEDGE OF BIOLOGY TO ANSWER QUESTIONS 35 AND 36:

A student is breathing into and out of the mouthpiece. The air he breathes <u>in</u> passes through bottle B, and the air he breathes <u>out</u> passes through bottle A. Bottles A and B contain Bromothymol Blue. Bromothymol Blue is blue in a basic solution and yellow in an acidic solution. (Note that a one-way valve only lets air go in the direction the arrow is pointing.)



35. From this observation alone, one can infer that
    a. carbon dicxide is leaving his lungs but not entering his lungs.
    b. only the air leaving his lungs contains a gas that made the solution in bottle A an acid.
    c. the air entering his lungs contains a gas that made the solution in bottle B an acid.
    d. there is no difference between the air entering and leaving his lungs.

36. The student set up an identical experiment, but this time he jogged in place for 5 minutes before breathing through the bottles. This time the
    a. results would be identical to the first experiment.
    b. liquid in bottle A would turn yellow more slowly.
    c. liquid in bottle B would turn yellow.
    d. liquid in bottle A would turn yellow faster.

USE THE FOLLOWING INFORMATION AND YOUR KNOWLEDGE OF BIOLOGY TO ANSWER QUESTIONS 37 AND 38:

Humans can be divided into four basic blood groups -

Blood Type	Antigen on Surface of Red Blood Cells	Antibodies in Plasma
O	None	Anti A and Anti B
A	A	Anti B
B	B	Anti A
AB	A and B	None

37. According to the chart, a person's blood group is determined by
    a. antibodies in the plasma.
    b. both the antibodies and the antigens.
    c. antigens on the red blood cells.
    d. antigens in the plasma.

38. Which would occur if a person with type A blood was accidentally given type B blood?
    a. There would be no reaction in the person.
    b. The antigens on the type A red blood cells would react with the antigens on the type B red blood cells, causing them to clump.
    c. Antigens on the red blood cells of type A blood would cause the antibodies in type B cells to clump.
    d. Antibodies in plasma of type A blood would make the type B blood cells clump.

USE THE FOLLOWING INFORMATION AND YOUR KNOWLEDGE OF BIOLOGY TO ANSWER QUESTIONS 39 AND 40:

In certain cases, it has been found that more than 2 alleles control the inheritance of a trait. Since each cell can only have a pair of alleles, the phenotype of the offspring will depend on which 2 out of the several are in the parents' cells. One example of this is the determination of blood group in humans. The chart below shows the relationship between phenotype and genotype for blood group in humans.

GENOTYPE	PHENOTYPE
$I^A I^A$ or $I^A i$	A
$I^B I^B$ or $I^B i$	B
$I^A I^B$	AB
ii	O

39. How many alleles control blood type in humans?
    a. 3
    b. 2
    c. 4
    d. 1

40. In order to have type O blood, you must
    a. be heterozygous for it.
    b. you must be homozygous for it.
    c. you must have three alleles that are the same.
    d. have both parents who are homozygous for A or B.

APPENDIX C

SHORT TERM AND LONG TERM ACHIEVEMENT DATA

* * * * * T-TEST (CORRELATED SAMPLES) * * * * *

PRETEST-POSTTEST ANALYSIS

File Name: COOP-VS-TRAD: 4 MISS. =-999999 LL =1 UL =19

var: 1 and var: 2

t(18)=-5.45367136 p= .0001

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* * * * * T-TEST (CORRELATED SAMPLES) * * * * *

COOPERATIVE LEARNING VS. TRADITIONAL LEARNING ANALYSIS

File Name: COOP-VS-TRAD: 4 MISS. =-999999 LL =1 UL =19

var: 3 and var: 4

t(18)=9.20902509 p= .0000

Name of Data File: COOP-VS-TRAD

VARIABLES	1	2	3	4
Subject: 1	14	17	28.4	22.8
Subject: 2	12	21	32.5	28.5
Subject: 3	17	24	34.5	29.9
Subject: 4	10	11	25.4	18.2
Subject: 5	13	18	33.5	22
Subject: 6	21	22	34.1	26.9
Subject: 7	15	17	32.3	27.6
Subject: 8	26	29	34.6	29.3
Subject: 9	20	21	33.5	32
Subject: 10	19	22	36.3	29.9
Subject: 11	16	19	34.6	29
Subject: 12	19	17	31.1	28.6
Subject: 13	16	19	34.3	30.1
Subject: 14	17	18	39.1	28.3
Subject: 15	12	18	27.3	22.1
Subject: 16	25	31	37.6	33.8
Subject: 17	12	22	27.8	25
Subject: 18	23	32	38.1	33
Subject: 19	19	26	35.4	31.9

VARIABLES: (1) Pre-test
(2) Post-test
(3) Cooperative learning
(4) Traditional learning

PRETEST-POSTTEST ANALYSIS (VARIABLES 1 & 2)

PRETEST MEAN: 17.1578947
POSTTEST MEAN: 21.2631579
T TEST VALUE: 5.45367136

COOPERATIVE LEARNING VS. TRADITIONAL LEARNING (VARIABLES 3 & 4)

PRETEST MEAN: 33.1789474 (COOPERATIVE LEARNING)
POSTTEST Mean: 27.8368421 (TRADITIONAL LEARNING)
T TEST VALUE: 9.20902509

NUMBER OF SUBJECTS PREFERRING COOPERATIVE LEARNING OUT OF 19: 15